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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE,*

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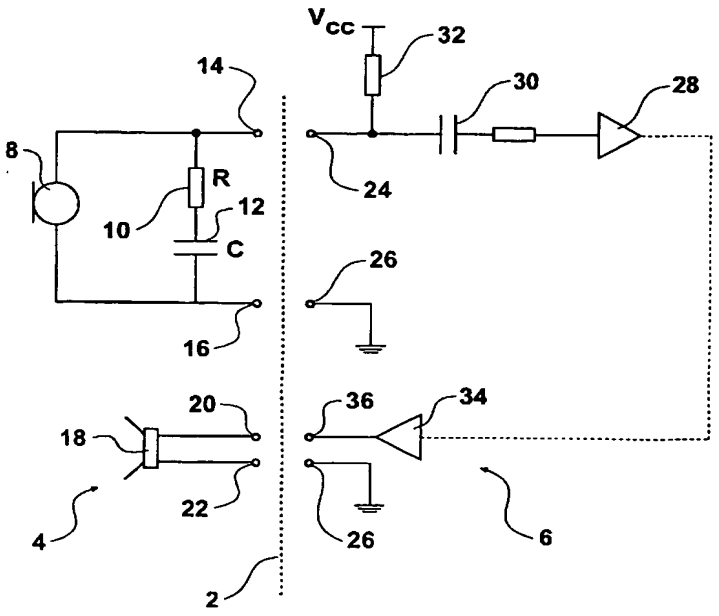
(54) Title: NOISE CANCELLATION SYSTEM AND HEADPHONE THEREFOR



(57) Abstract: Headphones, typically for airline passenger use and fitted with noise cancellation microphones, have a filter network attached to each headset to render the response of each microphone at least much of the way towards a normalised impedance/response curve. In this way various manufactures of headphones may be used with an onboard noise cancellation system which is actually optimised for one manufacturers headphones. The filter may be a simple high pass filter and is preferably built in to the headphone.

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Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Noise Cancellation System and Headphone Therefor

TECHNICAL FIELD OF THE INVENTION

The invention relates to noise cancellation systems, and is directed particularly, but not solely, towards a headphone noise cancellation system.

BACKGROUND OF THE INVENTION

Passenger vehicles, particularly commercial aircraft, have seat installations which include appropriate connections, i.e. jacks for receiving connection plugs for headsets and headphones. The user either provides their own, or is provided with, a headset which the user plugs into the jack provided on the relevant seat to listen to various audio channels. The terms headset and headphone are used interchangeably in this document since it is not relevant to the current invention whether a user microphone is fitted.

Recent developments to passenger audio systems include noise reduction systems which use noise reduction headphones or headsets. In one system the seat installation includes active noise cancellation electronic circuitry. The circuitry is operative to provide noise cancellation based on feedback from an appropriate sound transducer such as a microphone which is provided within the headset.

One problem associated with such a system is that noise cancelling electronics needs to be "tuned" to the headset in terms of the sensitivity and frequency response of the headset. Therefore only a narrow range of headset designs are generally able to be used effectively with each of these systems.

PRIOR ART

It is known to provide noise compensation systems with either noise cancellation built into the headphone or with a fixed noise cancellation system forming part of the system into which a

headphone is plugged. US patent 5 182 774 exemplifies the former type which have the noise cancellation tailored to each headphone type. The latter have previously been designed for use with only one manufacture of headphone and the noise cancellation is problematic with other types because of variations in frequency response and impedance which render the cancellation ineffective and can, at worst, result in positive feedback and instability.

OBJECT OF THE INVENTION

It is an object of the present invention to provide an improved noise cancellation system, or to provide an improved headset for a noise cancellation system, or to at least provide the public with a useful choice.

SUMMARY OF THE INVENTION

Accordingly in one aspect the invention consists in a noise cancellation system having:

a headphone including asound transducer and a headphone speaker,

noise cancellation circuitry provided remote from the headphone, supplying the headphone speaker, and being supplied from the sound transducer,

a filter to normalise the output from the sound transducer of the headphone to the noise cancellation circuitry.

Preferably the filter is located at the output of the sound transducer to enable effective noise cancellation to be achieved in use.

Preferably the filter comprises a passive electronic filter.

Preferably the filter comprises a resistor/capacitor network.

Preferably the filter is a high pass filter in parallel with the sound transducer.

Preferably the sound transducer comprises an electret condenser microphone.

In yet another aspect the invention consists in a headphone for a noise cancellation system, the headphone including,

one or more headphone speakers for providing sound to a user.

at least one sound transducer provided in the headset adjacent to the speaker, and

the output of the sound transducer being provided as an electrical signal and being provided to a filter, and the output of the filter being available to noise cancellation circuitry to cancel noise from the signal being delivered to the speaker.

DRAWING DESCRIPTION

Figure 1 is a circuit schematic of a noise cancellation system according to the invention

Figure 2 is a schematic of an equivalent circuit for a headset microphone and filter according to the invention,

Figure 3 is a schematic for one example of a practical implementation of the invention.

DESCRIPTION OF PREFERRED EMBODIMENT

In general terms, the invention provides a way of allowing noise cancellation circuitry which is typically provided remote from a headphone, to be able to provide effective noise cancellation for a number of different headphone designs. This is achieved by providing the noise cancellation headphone sound transducer (typically a microphone such as an electret condenser microphone) with a passive filter so that the feedback signal provided by the microphone is appropriately conditioned for a "generic" active noise cancellation circuit or normalised. Therefore, the invention allows the noise cancellation circuitry to be designed to be operative over a certain phase range of input feedback signals from a headset. This in turn means that a filter placed on the headset feedback signal may be appropriately configured for each different sort of headset so as to be acceptable to the noise cancellation circuitry and enable collective noise cancellation to be achieved.

The most preferred form of the invention the filter comprises a simple passive filter. Most preferably it is a resistor/capacitor filter as described further below. We have found that simple resistor capacitor passive filter provides an appropriate transfer function that is suitable for active noise cancellation applications. This simple passive filter may have the values of resistance or capacitance varied dependent upon the nature of the headphone, the headphone sound transducer etc.

Turning now to Figure 1, a schematic of an implementation of the invention as shown.

The headphone is shown to the left of dashed line 2 in the figure and is generally indicated by arrow 4. On the other side of the drawing, i.e. to the right hand side of dashed line 2, the noise cancellation circuitry is shown generally referenced 6.

By way of example, the noise cancellation circuitry may be provided in a portable electronic device such as a portable audio system including those sold under the trade mark WALKMAN. The circuitry could alternatively be provided in a home stereo system, a television set or a variety of other devices which provide sound to a user.

However, more typically, the noise cancellation circuitry 6 will be provided in a passenger vehicle. Again, a number of different forms of passenger transport may be provided so the noise cancellation circuitry may be provided in a seat installation (possibly an arm rest area) of a commercial aeroplane, a train, a bus. a private automobile, or the like.

In Figure 1, the sound transducer for the headphone 4 is an electret condenser microphone 8, and the output of the microphone is provided to a passive filter network comprising resistor 10 and capacitor 12. The output from the passive filter network is referenced 14 and 16, and these outputs are typically provided as pins on a plug which is acceptable to an appropriate jack or socket on the device that includes the noise cancellation circuitry.

Still referring to Figure 1, the headset 4 also includes a speaker 18 which has input signal connections 20 and 22. Again, connections 20 and 22 are in use electrically connected to an appropriate plug pins (not shown) so that they can be supplied with an appropriate electrical signal from the output of the noise cancellation circuitry that is provided in the corresponding socket remote from the headphone. Turning now to the noise cancellation circuitry, the input to the noise cancellation circuitry from the microphone is represented by inputs 24 and 26. Input 26 may be a reference such as ground, input 24 is provided to an amplifier 28 via capacitor 30. The power supply VCC and bias resistor 32 are also provided. The output of amplifier 28 is fed to noise cancellation circuitry which may comprise a passive network or be active, for example being implemented using a microprocessor. Noise cancellation circuitry which may be used is not described in this document, as it is known to those skilled in the art. The output from the noise cancellation circuitry is provided to an appropriate output amplifier 34 to be provided to output terminals 36 and 26 which connect to terminals 20 and 22 for the headphone speaker.

Turning now to Figure 2, further explanation of the passive filter network described above is illustrated. The sound transducer 8 in the preferred form of the invention comprises an electret condenser microphone. This microphone behaves as a current source from a signal viewpoint. Using a Norton to Thevenin conversion the microphone signal can be represented as a voltage source in series with the bias resistor, Rbias. . In Figure 2, the microphone signal is represented as voltage source 40, the output of which is in series with a bias resistor Rbias. The voltage source and bias resistor are in parallel with the passive filter comprising resistor 10 and capacitor 12. The network shown in Figure 2 provides a transfer function which is :

$$\frac{1 + sRC}{1 + s(R + R_{bias})C}$$

This is a suitable transfer function for active noise cancellation applications, i.e. the output from the circuit shown in Figure 2 is appropriate for provision to a "generic" active noise cancellation circuit.

Therefore, it can be seen that the values of resistance and capacitance of components 10 and 12 of Figure 2 may be chosen dependent upon the general acoustic properties of the headphone e.g. shape and size of the ear piece and orientation of the microphone relative to the speaker.

Finally, in Figure 3, a typically implementation is illustrated. The reference numerals used in this figure are the same as those used with reference to Figure 1 and it can be seen that resistor 10 has value of 3.3kΩ, capacitor 12 is 68 nanofarads, and the bias resistor 32 is 4.7kΩ.

Typically the headphone compensation is determined by targeting the noise cancellation at the best headphone to be catered for and then compensating other headphones to bring them to the same performance level.

From the foregoing, we see that the invention provides significant advantages in that a number of different headphones or headsets may be used to provide noise cancellation without having to redesign, alter or modify noise cancellation circuitry for which they are used. Therefore, noise cancellation circuitry may be designed to standard parameters and embodied in various devices such as personal stereos or passenger seat installations while allowing users to use their own preferred headset, or a variety of different headsets.

CLAIMS

1. A noise cancellation system having:

a headphone including a sound transducer and a headphone speaker,

noise cancellation circuitry provided remote from the headphone, supplying the headphone speaker, and being supplied from the sound transducer,

characterised in that a filter is provided to normalise the output from the sound transducer of the headphone to the noise cancellation circuitry.

2. A noise cancellation system as claimed in claim 1 characterised in that the filter is located at the output of the sound transducer to enable effective noise cancellation to be achieved in use.

3. A noise cancellation system filter as claimed in claim 2 characterised in that the filter comprises a passive electronic filter.

4. A noise cancellation system filter as claimed in claim 3 characterised in that the filter comprises a resistor/capacitor network.

5. A noise cancellation system filter as claimed in claim 4 characterised in that the filter is a high pass filter in parallel with the sound transducer.

6. A noise cancellation system as claimed in claim 1 characterised in that the sound transducer comprises an electret condenser microphone.

7. A headphone for a noise cancellation system, the headphone including,

one or more headphone speakers for providing sound to a user,

at least one sound transducer provided in the headset adjacent to the speaker, and

characterised in that the output of the sound transducer being provided as an electric signal and being provided to a filter, and the output of the filter being available to

noise cancellation circuitry to cancel noise from the signal being delivered to the speaker.

8. A headset as claimed in claim 7 characterised in that the filter is a high pass filter.

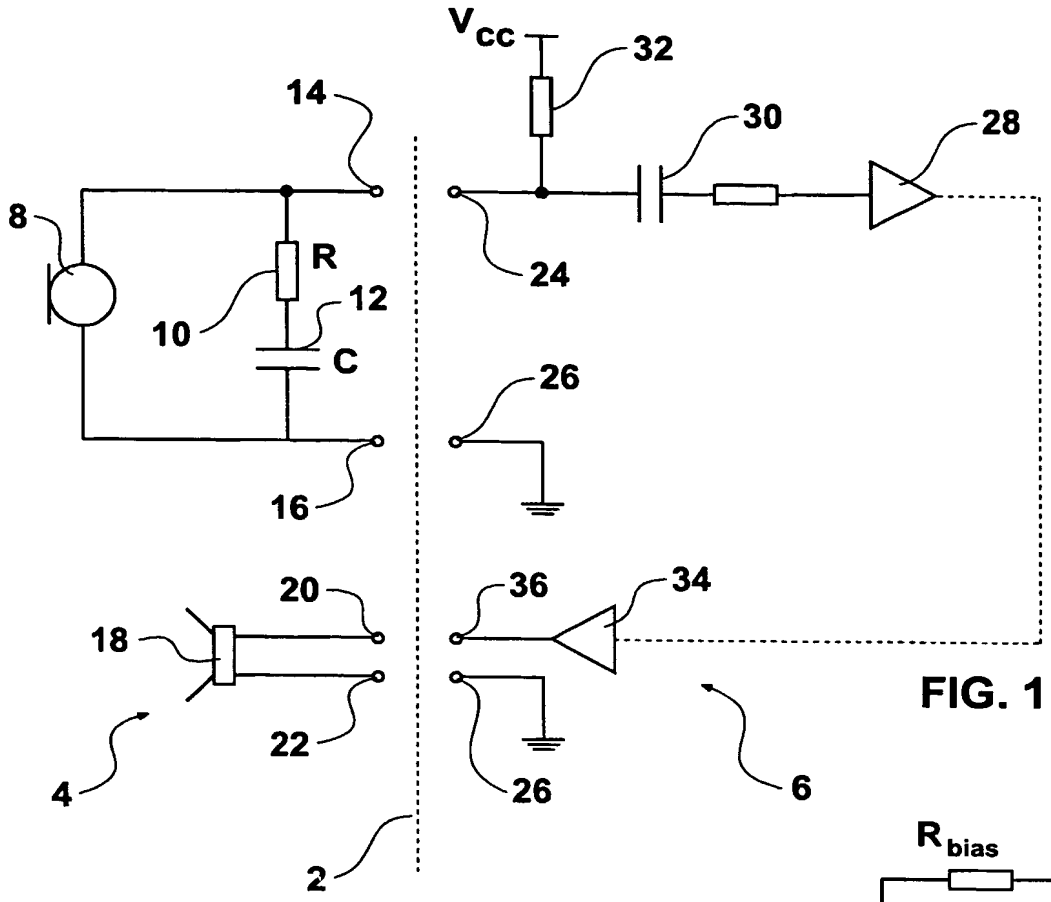

FIG. 1

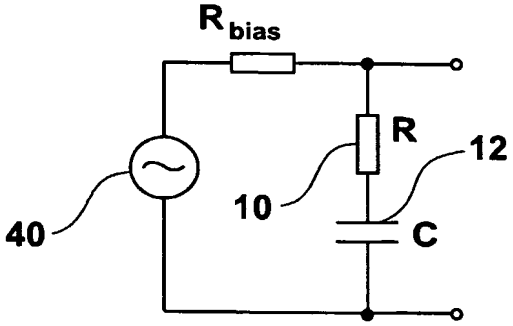

FIG. 2

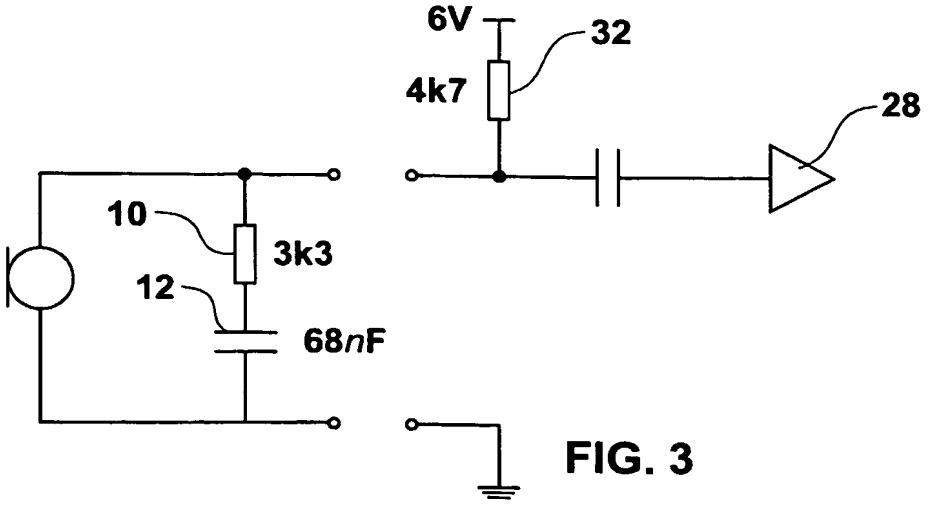

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ03/00134

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: A61F 11/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT: headphone, earphone, headset, noise, cancel, filter and similar terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 99/05998 A1 (TELEX COMMUNICATIONS, INC.) 11 February 1999 Abstract; Page 3, line 19 - page 4, line 9; Page 5, lines 8 - 27; Fig 3; All claims.	1 - 8
X	US 5815582 A (CLAYBAUGH ET AL) 29 September 1998 Abstract; Column 2, line 56 - column 3, line 26; Fig 2; All claims.	1 - 8
P,A	US 2003/0026438 A1 (RAY ET AL) 6 February 2003 Whole document	
A	WO 93/26084 A1 (NOISE CANCELLATION TECHNOLOGIES, INC.) 23 December 1993 Whole document	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 August 2003	
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ03/00134

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 93/25167 A1 (NOISE CANCELLATION TECHNOLOGIES, INC.) 23 December 1993 Whole document	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/NZ03/00134

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member	
WO	9905998	US	6278786
US	5815582	NONE	
US	2003002643	NONE	
WO	9326084	EP	643881
WO	9325167	EP	643571

END OF ANNEX